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RECOMMENDATIONS FOR THE PREPARATION OF DRAWINGS FOR OPTICAL ELEMENTS AND SYSTEMS

UDC 744·4 : 681·4

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INDIAN STANDARDS INSTITUTION
MANAK BHAVAN, 9 BAHADUR SHAH ZAFAR MARG
NEW DELHI 1

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Indian Standard

RECOMMENDATIONS FOR THE PREPARATION OF DRAWINGS FOR OPTICAL ELEMENTS AND SYSTEMS

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Indian Standard
RECOMMENDATIONS FOR THE PREPARATION OF DRAWINGS FOR OPTICAL ELEMENTS AND SYSTEMS

0. FOREWORD

0.1 This Indian Standard was adopted by the Indian Standards Institution on 15 October 1970, after the draft finalized by the Optical and Mathematical Instruments Sectional Committee had been approved by the Mechanical Engineering Division Council.

0.2 This standard is intended to lay the guidelines as to how the parameter of an optical system should be represented with the help of a drawing and where and how the tolerances as calculated from the design consideration should be introduced or represented to achieve the pre-set qualities. An attempt has been made to evolve a uniform code of drawing office practice amongst various optical manufacturers in order to avoid ambiguity and misinterpretation.

1. SCOPE

1.1 This standard gives recommendations for the presentation of design and functional requirements for optical elements and systems on drawings.

2. TERMINOLOGY

2.0 For the purpose of this standard, the definitions given in IS : 1399-1959*, IS : 1400-1960† and the following definitions shall apply.

2.1 Centring Error of a Lens — The condition which exists due to faulty manufacture when centres of curvature do not lie on the mechanical axis or when a plane surface is not normal to the mechanical axis.

2.2 Field Stop — The aperture of any of its images limiting the extent of the object viewed.

---

*Glossary of terms used in optical technology.

†Specification for optical glass.

2.3 Mechanical Axis (of a Lens) — The axis of the edge surface of a lens by which it is mounted.

2.4 Optical Parallelism — Optical parallelism exists when the optical path length is constant over the aperture at a given angle of incidence.

3. GENERAL REQUIREMENTS

3.1 Types of Drawings — Following three types of drawings are generally required.

3.1.1 *Optical Assembly* — An optical assembly drawing shall show the relative positions of all the components of a complete optical system and shall specify as appropriate the following:

a) Component part number,
b) Separation distances,
c) Overall magnification,
d) Magnification between adjacent image planes,
e) True field of view,
f) Position and sizes of field stops,
g) Position and sizes of pupils,
h) Details of light source,
j) Movement required for magnification and focus adjustment,
k) Reference to performance specification, and
m) Optical data summary of the assembly.

3.1.2 *Optical Sub-assembly* — An optical sub-assembly drawing shall give as appropriate the following:

a) Part numbers and assemblies on which used,
b) Dimensions and tolerances that are additional to those given in the detail drawings,
c) Equivalent focal length or other test data or both,
d) Special notes regarding assembly and testing procedure, and
e) Details of cement or other method of fixing, if specially used.

3.1.3 *Optical Detail* — An optical detail drawing shall give as appropriate the following:

a) Assembly or sub-assembly on which used,
b) Material specification,
c) Dimensional data,
d) Tolerances for dimensions,

e) Surface treatment, and

f) Tolerances for surface quality.

3.2 Orientation of Drawings — Orientation of assembly drawings shall be such that the ultimate receptor, for example the eye, projection screen, photographic plate or photo-electric cell shall appear to be on the right-hand side unless shown otherwise on the corresponding mechanical assembly drawing. In sub-assembly and detail drawings, components shall be oriented with optical axes horizontal or as they appear on the assembly drawing or both ways.

4. METHODS OF REPRESENTATION

4.1 Optical axes shall be shown as thin chain dotted lines as in Fig. 1.

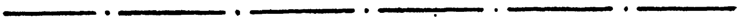


Fig. 1

4.2 Optical materials, when in section, shall be shown as in Fig. 2.

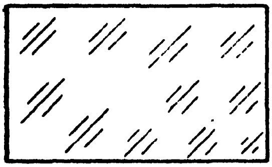


Fig. 2

4.3 Components containing curved surfaces shall only show the profile in the axial plane (*see* Fig. 3).

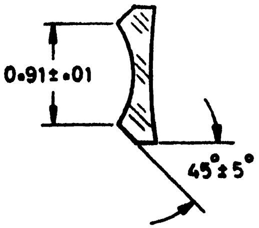


Fig. 3

4.4 Field stops and pupils in assembly drawings shall be indicated (*see* Fig. 4) as follows:

a) Position of field stops shall be indicated by a cross (that is ×) on the optical axis,

b) Position of pupil shall be indicated by a short line across the optical axis, and

c) Dimensions of field stops and pupils shall be indicated.

4.5 Wherever possible, general notes shall be grouped together and preferably numbered for case of reference.

4.6 Where the positions of components may be varied by the user in optical assemblies so as to adjust focus, magnification, etc, the components shall be shown in nominal positions and dimensions given for the extreme positions. Adjustments that are to be made during assembly, shall be indicated by a note (*see* Fig. 4 and Table 1).

5. MATERIALS

5.1 Requirements for the component material shall be entered into a special panel giving, as appropriate, the following information:

a) Material (type),

b) Manufacturer's name and catalogue number or reference,

c) Refractive index at a given wave length, and

d) Number of Indian Standard to which the material shall conform.

6. DIMENSION

6.1 Chamfers or bevels applied for design reasons shall be shown and dimensioned. The width and angle of the chamfer shall preferably be stated together with appropriate tolerance (*see* Fig. 5). Alternatively, in the case of lens when straight forward measurement is possible, the aperture limited by a chamfer shall be dimensioned (*see* Fig. 3).

6.2 Protective chamfers shall not be shown but shall be indicated in the form of a note. In special cases, they shall be indicated by a leader drawn to the edge in question. According to need, their minimum and maximum values both or their maximum value only shall be indicated (*see* Fig. 6). When it is not permissible for an edge to be chamfered, a special note shall be added as in Fig. 7.

Edges provided with protective chamfers shall be dimensioned for the sharp-edged condition.

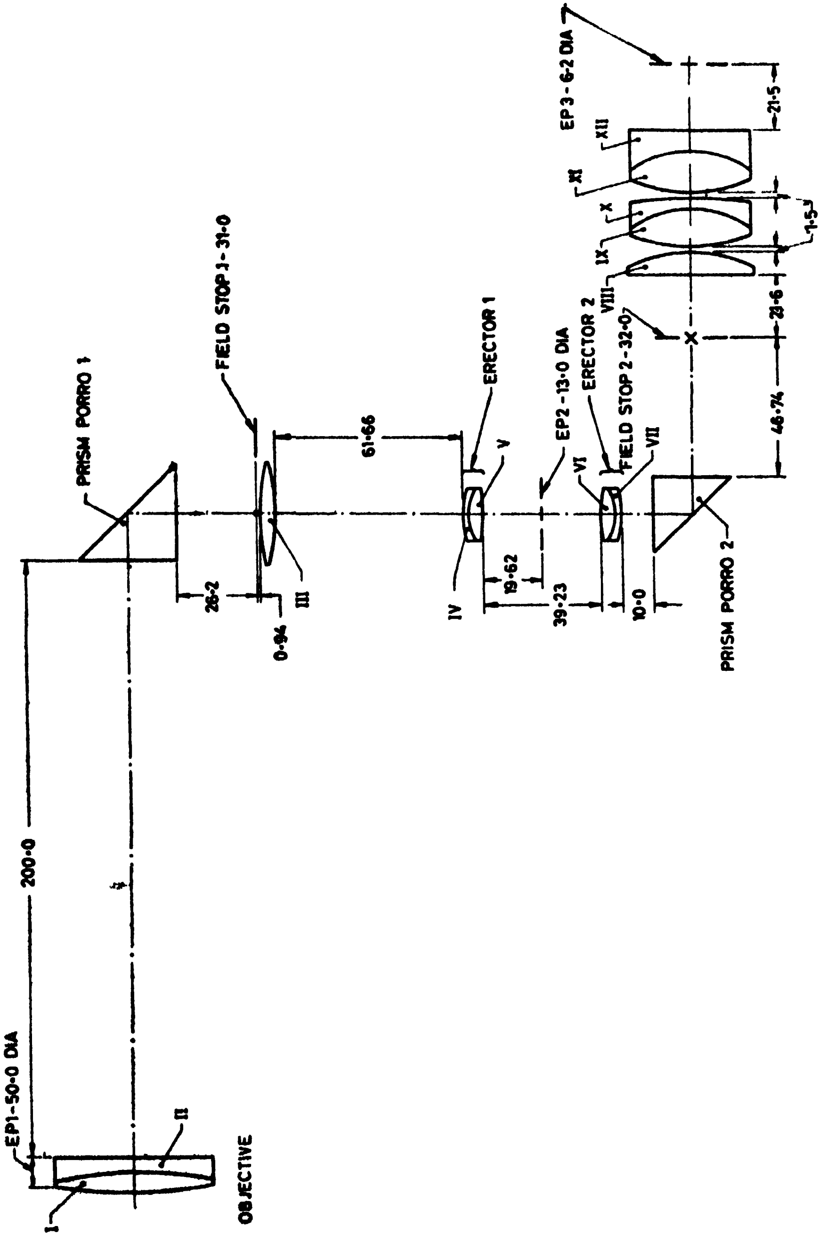
6.3 The diameter of a lens shall be shown with a unilateral tolerance. The nominal size of the clear aperture shall be put in brackets and where this differs between one side and the other, the values concerned shall be stated separately (*see* Fig. 8 and 9).

6.4 Axial thickness shall be shown with a bilateral tolerance (*see* Fig. 10). In the case of lenses having concave surfaces, the overall thickness shall also be indicated (*see* Fig. 11 and 12).

TABLE 1 DIMENSIONS

(*See also* Fig. 4)

	LENS No.	GLASS TYPE	N_d	V	R_1	R_2	R_3	R_4	R_5	R_6	R_7	R_8	R_9	R_{10}	R_{11}	R_{12}	R_{13}	R_{14}	R_{15}	R_{16}	R_{17}	R_{18}	R_{19}	CENTRE THICKNESS	CLEAR APERTURE	DIA	FOCAL LENGTH	COMBINED FOCAL LENGTH
Objective	I	BSC 510644	1·5097	64·4	136·79 Convex	112·86 Convex																		7·62	50·0	52·0	122·24	254·0
	II	EDF 651336	1·6511	33·6		112·86 Concave	440·5 Convex																	5·08	50·0	52·0	-233·21	
Field Lens	III	BSC 510644	1·5097	64·4				72·99 Convex	72·99 Convex															5·08	33·0	35·0	72·25	
Erector 1	IV	EDF 648338	1·6479	33·8						37·84 Convex	17·084 Concave													1·98	16·0	18·0	–49·69	67·03
	V	HC 521579	1·5210	57·9							17·084 Convex	97·62 Convex												4·60	16·0	18·0	28·21	
Erector 2	VI	HC 521579	1·5210	57·9									97·62 Convex	17·084 Convex										4·60	16·0	18·0	28·21	67·03
	VII	EDF 648339	1·6479	33·8										17·084 Concave	37·84 Convex									1·98	16·0	18·0	–49·69	
Eye Piece	VIII	BSC 510644	1·5097	64·4												α	46·08 Convex							7·2	40·0	42·0	90·16	
	IX	BSC 510644	1·5097	64·4														54·76 Convex	33·31 Convex					12·9	38·0	40·0	42·64	94·56
	X	DF 623360	1·6226	36·0															33·31 Concave	128·69 Convex				3·6	38·0	40·0	–72·88	
	XI	DBC 614599	1·6142	59·9																	49·31 Convex	33·31 Convex		14·3	33·0	40·0	34·55	02·33
	XII	DF 626357	1·6258	35·7																		33·31 Concave	α	7·2	33·0	40·0	–52·97	
Prism Porro 1		BSC 510644	1·5097	64·4	Size of face — 32·0 mm square; Equivalent airpath — 21·18 mm; Clear aperture — 30·0 mm Dia																							
Prism Porro 2		BSC 510644	1·5097	64·4	Size of face — 25·4 mm square; Equivalent airpath — 16·81 mm; Clear aperture — 20·0 mm Dia																							



All dimensions in millimetres.

FIG. 4

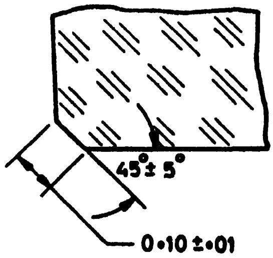


Fig. 5

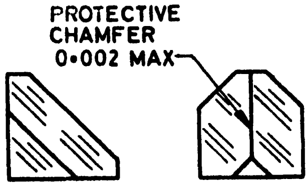


Fig. 6

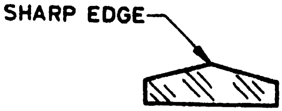


Fig. 7

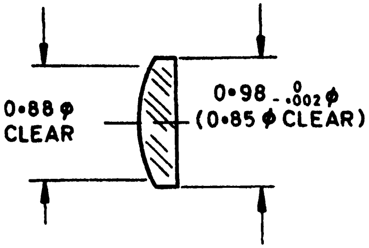


Fig. 8

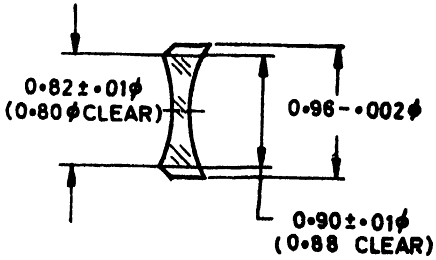


Fig. 9

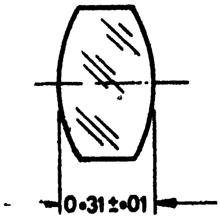


Fig. 10

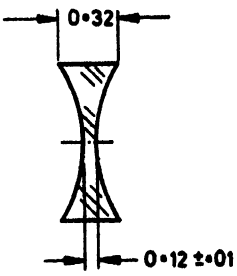


Fig. 11

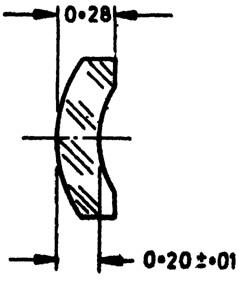


Fig. 12

6.5 The radius of a spherical surface shall always be given with a tolerance (*see* Fig. 13).

6.6 Plane surfaces, a special case of spherical surfaces, shall be indicated by an infinity radius and a sphericity tolerance in fringes (*see* Fig. 13).

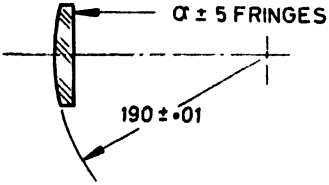


Fig. 13

6.7 Axial misalignment in the form of a parallel offset between the optical axis and the ground edge shall be dimensioned if intentional (*see* Fig. 14).

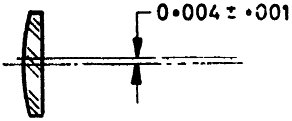


Fig. 14

6.8 The tolerance for the centring error shall be entered in the drawing of the component with a leader to the edged surface (*see* Fig. 15). The permissible centring tolerance for cemented optical components shall similarly be expressed on optical sub-assembly drawings (*see* Fig. 16).

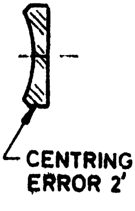


Fig. 15

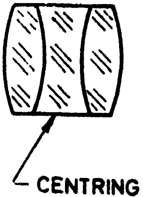


Fig. 16

6.9 Angles including right angles shall be indicated as nominal sizes with a bilateral tolerance (*see* Fig. 17). Where angles of deviation are concerned, the nominal value with bilateral tolerance shall be given in the form of a note, for example 'Angle of deviation 90° ± 2°'.

6.10 Permissible parallelism variations shall be indicated in angular terms (*see* Fig. 18). Where special requirements are desired regarding parallelism between edges and surfaces, the edges and surfaces in question shall be identified by lower case letters and the degree of parallelism to be observed stated in angular terms in the form of a note (*see* Fig. 19).

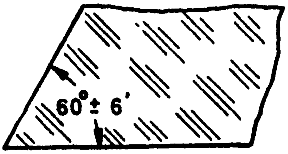


Fig. 17

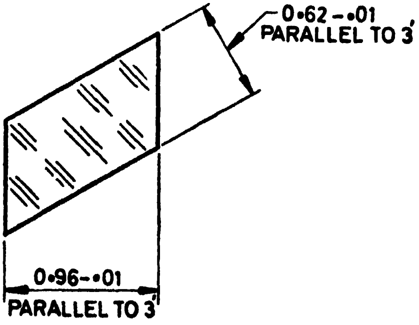
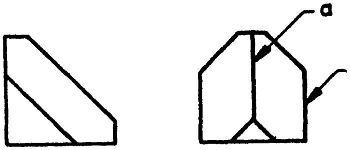


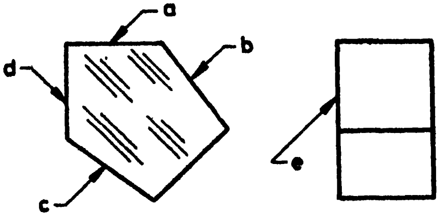
Fig. 18



EDGE a PARALLEL TO SURFACE b TO 10'

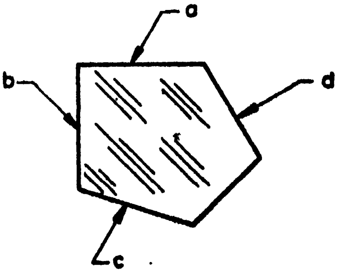
Fig. 19

6.11 The perpendicularity of several different surfaces to a reference surface shall be referred to the latter. The surfaces in question shall be indicated by lower case letters and the necessary particulars regarding perpendicularity shall be given in the form of a note (*see* Fig. 20). In cases when it is not desirable to use a reference surface, the parallelism of a number of surfaces shall be related to the direction defined by the intersection of two specially indicated surfaces; these shall be selected to be as nearly as possible, perpendicular to each other (*see* Fig. 21).



SURFACES 'a', 'b', 'c', AND 'd' PERPENDICULAR TO SURFACE 'e' TO 2'

Fig. 20

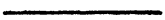
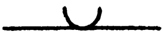
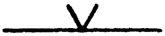
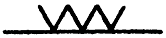
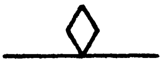
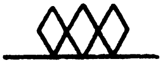


SURFACES c AND d PARALLEL WITH INTERSECTION OF SURFACES a AND b TO WITHIN 2'

Fig. 21

7. SURFACE FINISH

7.1 Surface finish shall be indicated by the symbols as shown below; the symbols being placed either against the edges of the items depicted or against the associated dimensional leaders:

Surface Finish	*Symbol*
Rough surfaces	
Bright surfaces as produced	
Rough ground surfaces	
Fine ground surfaces	
Rough polished surfaces	
Fine polished surfaces	

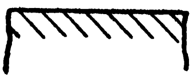
8. FIGURE

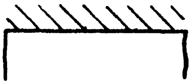
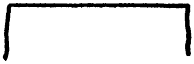
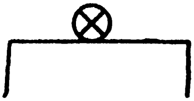
8.1 The departure from spherecity or flatness of a surface shall be indicated in terms of maximum symmetrical and asymmetrical fringe tolerance.

8.2 The tolerance on a spherical surface shall be indicated by a separate note.

9. SURFACE TREATMENT

9.1 Coated surfaces shall be indicated by symbols given below in addition to descriptive wording:

Type of Layer	*Symbols*
Rear surface metallized	

Type of Layer	*Symbols*
Front surface metallized	
Partial reflection	
Anti-reflection coating	

10. JOINING OPTICAL COMPONENTS

10.1 Cemented part shall be indicated by a leader to the joint concerned (*see* Fig. 22).

10.2 Alternative method of fixing (that is optically contacted or fused surfaces) shall be described by a suitable note and a leader to the joint concerned (*see* Fig. 23).

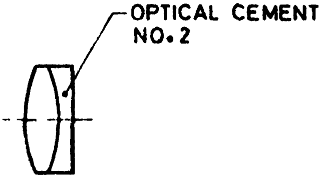


Fig. 22

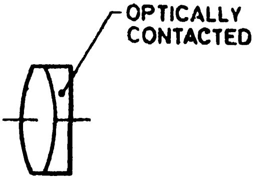


Fig. 23

PUBLICATIONS OF INDIAN STANDARDS INSTITUTION

INDIAN STANDARDS

Over 6 000 Indian Standards, broadly classified under the following main heads, have been issued so far:

- **Agriculture & Food**
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- Gas Cylinders and Fittings
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- Gears
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- IC Engines and Automotive Vehicles
- Instruments (Drawing, Optical and Surveying)
- Machine Tools and Small Tools
- Marine Engineering and Shipbuilding
- Material Handling, Lifting Gear
- Mining
- Pumps
- Refrigeration and Air-Conditioning
- Sewing Machines
- Steam Tables
- Threaded Fasteners and Rivets
- Transmission Devices, Pulleys and Belts
- Weights and Measures
- Wire Ropes and Wire Products
- Unclassified

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